FCC/USCG DSC Laboratory Testing Report

I. BACKGROUND

1. Prior to the 1980's, maritime distress calling and coordination relied primarily on ship-to-ship communications, essentially relying on every ship being a "lifeboat" (potential rescuer) for every other ship. In the early 80's, the International Maritime Organization (IMO) undertook to develop an organized and coordinated system for maritime safety. The Global Maritime Distress and Safety System (GMDSS) amendments to the International Convention for the Safety of Life at Epsilon (Safety Convention) has replaced the old system with a ship-to-shore based safety system that relies on, among other things, automated MF/HF radio equipment using Digital Selective-Calling (DSC). The system was implemented starting in 1992, with full global implementation scheduled to occur on February 1, 1999.

2. DSC uses six dedicated MF/HF frequencies for distress and safety calling purposes. Each of these frequencies has an associated telephony and data channel that is to be used for communications purposes after the Distress Call is made and acknowledged. Table 1 lists these frequencies:

Table 1

DSC Distress Frequency	Associated voice frequency	Associated data frequency
2187.5 kHz	2182 kHz	2174.5 kHz
4207.5 kHz	4125 kHz	4177.5 kHz
6312 kHz	6215 kHz	6268 kHz
8414.5 kHz	8291 kHz	8376.5 kHz
12577 kHz	12290 kHz	12520 kHz
16804.5 kHz	16420 kHz	16695 kHz

3. The United States Coast Guard (USCG) is charged in the U.S. with communications monitoring and Search and Rescue activities associated with maritime distress. In discussions with the FCC, the USCG reported problems with DSC Distress Calls and Distress Relay calls. The FCC and the USCG entered into an agreement to have the FCC test HF DSC radios for compliance with certain aspects of the IMO Chi for HF DSC radios. The testing location was at the FCC Laboratory in Columbia, MD.[1]

The specific purpose of the testing was to determine whether HF DSC radios contribute to the problem

of false Distress Calls and Distress Relay calls. There are reportedly many more Distress Relay calls than there are distress alerts. For example, in August 1998, there were 1207 Distress Relay calls and 39 Distress Calls reported by CAMSLANT, CAMSPAC and others.[2]

5. The testing conducted by the FCC only tested certain capabilities of HF DSC transceivers intended for use on ships. The testing did not include testing of coast station transceivers or DSC call initiated by a Coast station. Specifically, it did not test the effects of a Distress Relay Acknowledgement.

II. TEST PHILOSOPHY

6. The initial test objective was to test the Distress Call and Distress Relay call capability of the DSC HF radios. In setting up the testing, several considerations were taken into account; for example, we ensured that the test set-up did not permit any Distress Call to be transmitted over the air. The test plan included steps to ensure that the HF DSC radios complied with the aspects of the IMO standard regarding distress alerts and Distress Relay alerts.[3] Finally, the test objective was to provide the USCG with a report of the results, any conclusions and recommendations.

III. EQUIPMENT

7. Five HF DSC transceivers tested[4]:

8. Test equipment used.
   a. Rockwell Collins HF receiver.
   b. IBM laptop with installed HOKA data processing card and software.
   c. Hewlett Packard spectrum analyzer.
   d. Wideband antenna.

IV. PROTOCOL

Interference Prevention

9. Radio transceivers were terminated into dummy loads. Low (receiver) level signals were sampled from the main RF line and combined and redistributed in a multicoupler. The multicoupler fed all watch receiver ports and other instrumentation.

10. Used a Rockwell Collins HF receiver and a wideband antenna to scan all DSC distress frequencies to ensure that there was no over the air transmission of DSC Distress Calls.

11. Each radio was assigned a temporary Maritime Mobile Service Identifier (MMSI). The MMSIs were obtained from the FCC's office in Gettysburg, PA, and were reserved solely for FCC use in testing. The Gettysburg office was informed that the tests were taking place and to refer any requests regarding the MMSIs to George Dillon. Additionally, each radio was assigned a latitude and longitude of 89 degrees 59 minutes North, 0 degrees XY minutes West where XY was the last two digits of the assigned MMSI. *See* Table 2 for the assigned MMSIs and the assigned positions.

Table 2

Transceiver	**Assigned MMSI**	**Assigned Latitude**	**Assigned Longitude**
A	367112011	89° 59'N	000° 11'W
B	367112012	89° 59'N	000° 12'W
C	367112013	89° 59'N	000° 13'W
D	367112014	89° 59'N	000° 14'W
E	367112015	89° 59'N	000° 15'W

V. TESTING

Test Set-up.

12. Five radios were interconnected with one another to simulate over the air reception, as described earlier. The transmitter output of each radio was terminated into a dummy load of sufficient size to handle full output power. Where possible the high power amplifier (HPA) of the transceiver was not used, in order to minimize output power. A sampling port was connected between the dummy load and the transceiver. A sampled signal at receiver levels was fed into a resistive multi-port combiner for each transmitter. The combiner was used to feed receiver level signals from all transmitters into the watch receiver of each of the radios. Outputs from the combiner were also used

to feed the Collins HF receiver to monitor the DSC codes, as well as the Hewlett Packard spectrum analyzer. The combiner output level to the receiving devices was approximately -40 dBm to -20 dBm. See ATTACHMENT A.

Results

13. *Distress Call attempt, § 11.1.*

Transmitted an "All Ships" Distress Call on 2 MHz DSC distress frequency and verified the Distress Call was received by all other transceivers. Verified that the transmitted code was all ships using the Collins HF receiver and the HOKA decoder. All transceivers were capable of transmitting an "All Ships" Distress Call and of receiving an "All Ships" Distress Call with no errors. All transceivers required two independent actions to transmit an "All Ships" Distress Call. All transceivers continued to repeat the "All Ships" Distress Call until they received a Distress Acknowledgement.[5] All transceivers tuned to 2182 kHz, the radiotelephone voice channel upon receiving a Distress Acknowledgement on the 2 MHz Distress frequency.

All transceivers passed these tests.

14. *Repeat of Distress Call.* A Distress Call may be transmitted as a single frequency or a multi-frequency call attempt.[6]

a. Transmitted an all-ships Distress Call and verified whether transceiver repeated Distress Call on single frequency or on multiple frequencies. *See* Table 3 for a summary:

Table 3

B	Does not have an option to sequentially transmit Distress Call on all DSC distress frequencies, one after the other, *e.g.* 2 MHz, 4 MHz, 6 MHz, 8 MHz, 12 MHz, 16 MHz. Gives the option for manual selection of any DSC distress frequency and automatic repeat on that frequency.
A	Does not have an option to sequentially transmit Distress Call on all DSC distress frequencies, one after the other, *e.g.* 2 MHz, 4 MHz, 6 MHz, 8 MHz, 12 MHz, 16 MHz. Gives the option for manual selection of any DSC distress frequency and automatic repeat on that frequency.
D	Does not have an option to sequentially transmit Distress Call on all DSC distress frequencies, one after the other, *e.g.* 2 MHz, 4 MHz, 6 MHz, 8 MHz, 12 MHz, 16 MHz. Gives the option for manual selection of any DSC distress frequency and automatic repeat on that frequency.
C	Gives the option to sequentially transmit Distress Call on all DSC distress frequencies. Transmitted Distress Call on 2187.5 kHz; then on 8414.5 kHz; then on 4207.5 kHz; then on 6312 kHz, then on 12577 kHz, and then on 16804.5 kHz. Transceiver C provides a listening watch to receive the Distress Acknowledgement.
E	Gives operator the option to initiate multi-channel Distress Call on all DSC distress frequencies. When multi-channel option is selected, Transceiver E transmits one Distress Call on each of the DSC distress frequencies.
All transceivers provided a listening period for the Distress Acknowledgement.	

15. Transmitted an all-ships Distress Call and verified whether a Distress Acknowledgement transmitted on a DSC distress frequency other than the one that the transceiver is using to transmit on, will cause the transmitter to cease sending a repeated Distress Call. *See* Table 4 for a summary:

Table 4

Scenario. Transmit DSC Distress on 2187.5 kHz. Check for auto repeat. Transmit a Distress Acknowledgement on 8414.5 kHz.	
B	Distress Acknowledgement on 8414.5 kHz does NOT cause transceiver B to stop sending a Distress Call on 2187.5 kHz. Requires a Distress Acknowledgement sent on 2187.5 kHz.
A	Distress Acknowledgement on 8414.5 kHz does NOT cause transceiver A to stop sending a Distress Call on 2187.5 kHz. Requires a Distress Acknowledgement sent on 2187.5 kHz.
D	Distress Acknowledgement sent on 8414.5 kHz causes transceiver D to cease sending a DSC Distress Call on 2187.5 kHz.
C	Sending a Distress Acknowledgement on 8414.5 kHz causes transceiver C to cease sending a Distress Call on 2187.5 kHz.
E	When transceiver E transmits its original Distress Call on 2187.5 kHz, it does not accept a Distress Acknowledgement on 8414.5 kHz. When multi-channel option is selected, to sequentially transmit Distress Call on all DSC distress frequencies, one after the other, *e.g.* 2 MHz, 4 MHz, 6 MHz, 8 MHz, 12 MHz, 16 MHz, sending a Distress Acknowledgement on 8414.5 kHz causes transceiver E to cease sending a Distress Call.

16. Audible alarm, § 12.

a. All transceivers had an audible alarm that was activated upon reception of an "All Ships" Distress Call and continued to sound until manually stopped.

17. *Distress Acknowledgement*, § 1.8

a. Transmitted Distress Call and verified that all transceivers would cease transmitting a Distress Call upon receiving a Distress Acknowledgement addressed to the initiating transceiver's MMSI. All transceivers passed this test.

b. Transmitted a Distress Call and verified that transceivers would not cease transmitting a Distress Call upon receiving a Distress Acknowledgement not addressed to the initiating transceiver's MMSI. The D radio failed this test; all other radios passed this test. The D radio ceased transmitting a Distress Call upon receiving any Distress Acknowledgement.

c. Transmitted a Distress Call on multiple DSC frequencies using the C radio and the E radio.

Transmitted a Distress Acknowledgement on a DSC distress frequency and verified that the E and C transceivers would stop auto repeat. Both radios passed.

18. *Automatic Distress Relay.* Attempted to make transceivers transmit an automatic Distress Relay. Verified that none of the transceivers tested would automatically repeat the Distress Call. All transceivers passed this test.

19. *Distress Relay.* Tested radios to see if they were capable of relaying a Distress Call. All radios passed this test.

20. *Relay of a Distress Relay.* Tested radios to see if they were capable of relaying a Distress Relay.

a. All of the radios allow the operator to construct a Distress Relay from the menu. The B radio requires the operator to manually enter the MMSI of the ship in distress. The E radio prompts the user by asking whether the operator knows the MMSI of the ship in distress. The A radio asks if you know the MMSI of the ship in distress. See ¶ 21 for discussion about the C transceiver. *See* Table 5.

Table 5

Scenario: Transmit a Distress Call, then a distress acknowledgment, then construct a Distress Relay of the Distress Call. Check to see what MMSI is relayed as the ship in distress. Radio A transmits the DSC Distress Call on 2187.5 kHz. Radio B acknowledges the DSC Distress Call.			
Radio E does not permit it, and when you construct the Distress Relay it asks for MMSI.	Radio D uses MMSI of ship in distress.	Radio B requires manual input.	Radio A requires manual input.

21. *Other.* In testing whether a transceiver could relay a Distress Relay we noted that when we constructed a Distress Relay after a Distress Call that radio C inserted the MMSI of the ship in distress into the field for the ship in distress as is allowed in ITU recommendation ITU-R M.493-8. We also noted, however, that when radio C received either a Distress Relay or a Distress Acknowledgement after the Distress Call that radio C inserted the MMSI of the transceiver that had relayed or acknowledged the distress. No other radios did this. Radio C has stated that they will fix this problem on the next software release. *See* Table 6 and 7.

Table 6

1. Initiate a Distress Call using a transceiver with an assigned MMSI of 367112011.
2. Radio C with an assigned MMSI of 367112013 receives the Distress Call.
3. Construct Distress Relay call using radio C without editing entries.
4. The transmitted Distress Relay call uses the MMSI of the transceiver that initiated the Distress Call –367112011--as the ship in distress and is accurate.
5. The MMSI of the transceiver relaying the Distress Call --367112013--is accurate.

Table 7

1. Initiate a Distress Call using a transceiver with an assigned MMSI of 367112011.
2. Radio C with an assigned MMSI of 367112013 receives Distress Call.
3. Then, prior to constructing a Distress Relay call, Radio C receives a Distress Relay Call or a Distress Acknowledgement from a transceiver with an assigned MMSI of 367112012.
4. Construct Distress Relay call without editing entries.
5. The transmitted Distress Relay call uses the MMSI of the transceiver that initiated the Distress Relay call or the Distress Acknowledgement—367112012--as the ship in distress and is inaccurate.
6. The MMSI of the transceiver relaying the Distress Call --367112013--is accurate.

VI. CONCLUSIONS

22. The five radios tested all met the recommended Standard for HF DSC radios. All were able to transmit and receive Distress Calls. All were able to receive Distress Acknowledgements from the other ship radios. There were, however, distinct differences in the implementation of the Standards by the manufacturers.

VII. RECOMMENDATION

23. Contingent upon resource availability, continue tests with Coast station using a coast station transmitter and software to generate a Distress Relay Acknowledgement. Consider testing other models of ship station HF DSC transceivers. We are aware of at least three other products that have been or will soon be marketed in the U.S.: Radios from Skanti, Icom and SGC. Also, there is at least one product we are aware of which is sold in Asia but not in the U.S (Anritsu). Expand the testing of transceivers we already have in hand to fully test the effects of transmitting a distress relay

acknowledgement from the Coast Guard coast station.

VIII. ADDENDA

24. On October 29, 1998, additional tests on the five HF DSC ship transceivers were conducted and the Coast Guard furnished HF DSC coast station. The tests consisted of two parts: Distress Relay Call and Distress Relay Acknowledgement; and, a test to determine if there are discernable differences in the displayed messages when the ship's transceivers receive a Distress Acknowledgement and a Distress Relay Acknowledgement. The results are summarized in Tables 8 and 9 respectively.

Table 8 Distress Relay Call

Transmit a Distress call using a ship transceiver.	Initiate a Distress Relay Call using another ship transceiver. Record the results. *e.g.* Does the transceiver repeat the Distress Relay?	Transmit a Distress Relay Acknowledgement using the Coast Guard transceiver. Record the message received and the results. *e.g. Did* the transceiver stop transmitting the Distress Relay?
Results		
Radio C	Radio C repeated the Distress Relay Call until it received a Distress Acknowledgement addressed to the ship in distress.	Radio C continued to transmit the Distress Relay after it received a Distress Relay Acknowledgement from the Coast Guard transceiver. It is not readily apparent from the message received that the message is a Distress Relay Acknowledgement. The only clue is that the display shows a "ackn received" and the MMSI of the Coast Guard transceiver begins with 00.
Radio B	Radio B did not repeat the Distress Relay Call.	It is not readily apparent that the message received is a Distress Relay Acknowledgement.
A	Radio A did not repeat the Distress Relay Call.	It is not readily apparent that the message received is a

		Distress Relay Acknowledgement.
D	Radio D did not repeat the Distress Relay Call.	It is not readily apparent that the message received is a Distress Relay Acknowledgement.
E	Radio E did not repeat the Distress Relay Call.	It is not readily apparent that the message received is a Distress Relay Acknowledgement.

25. *Concern.* A Distress Relay Acknowledgement does not stop radio C from continuing to retransmit a Distress Relay call, only a Distress Acknowledgement addressed to the ship in distress did that.

Table 9--Messages

Transmit a Distress Call using a ship transceiver.	Initiate a Distress Acknowledgement using another ship transceiver. Record the results. *e.g.* What does the message look like to the operator?	Initiate a Distress Relay Acknowledgement using the Coast Guard transceiver. Record the results. *e.g.* What does the message look like to the operator?
Radio C	DSC All ship alert received Priority Distress From 367112014 Distress Acknow. ID 367112013. Nature Undesignated distr. Position 89 59 N 000 13 W Time: UTC None Phone H3E No Ackn requested. Connect Radio Y/N	DSC All ship alert received Priority Distress From 003660002 Distress Acknow. ID 367112013. Nature Undesignated distr. Position 89 59 N 000 13 W Time: UTC None Phone H3E No Ackn requested. Connect Radio Y/N
Radio B	Received Message RX date and time: 29 Oct 1998 (Thu) 21:12 Format: all ships Address: 367112014 Category: Distress Telecommand-1: Distress Ack Dist-Address: 367112012 Nature: Undesignated dist Dist-Position: N89'59 W000'12 Dist-UTC:14:43	Received Message RX date and time: 29 Oct 1998 (Thu) 21:12 Format: all ships Address: 003660002 Category: Distress Telecommand-1: Distress Ack Dist-Address: 367112012 Nature: Undesignated dist Dist-Position: N89'59 W000'12 Dist-UTC: 14:44
Radio E	DISTRESS CALL MODE CHAN 90 2187.5 kHz Distress ACKNOWLGED Button kills alarm. *Stay on channel for radiotele calls Press 1=pos-update 0=exit-dstress mode 1	DISTRESS ACK SHIP 367112015 CHAN 01 mf UTC:2053 10/29/98 POS: N 89 59 W 000 15 undesignated by 003660002 to all ships NOER COM: J3E VOICE buttonAlarm Call Mode CHAN 90 2187.5 kHz Distress ACKNOWLGED Button kills alarm. *Stay on channel for radiotele call.

		After alarm is cancelled additional instruction is displayed" Use phone or EX=0"
Radio A	Received*DISTRESS ACK ID 367112014 2187.5 kHz Dist ship: 367112011 ABBANDONING SH	Received*DISTRESS ACK ID 00366000267112014 2187.5 kHz Dist ship: 367112011 ABANDONING SH
Radio D	Received message "All ships Dist"	Received message "All ships Dist"

Concern. It is very difficult to distinguish between a "Distress Acknowledgement" sent by a ship station and a "Distress Relay Acknowledgement" sent by a coast station.

Other. The following tables provide information on :

position latency—how long a manually inputted position is valid—this information was determined from the equipment manuals unless otherwise specified;

operator required steps to initiate a Distress Relay to a coast station; and,

limitations on inserting the ship station MMSI.

Table 1010

	Position Latency	Source
Radio C	Does not appear to expire.	Manual does not provide information.
Radio B	Position has to be updated after unit is powered off.	Observation.
Radio E	Position must be entered manually. Does not appear to expire.	From manual.
Radio A	Manually inputted position expires 12 hours after input.	From manual.
Radio D	Position appears to expire.	Manual states that manual position expires after 12 hours.

Table 1111

Relay to a Coast Station		Source
Radio C	The Distress Relay option is normally disabled and must be enabled through the Setup menu. Operator selects Distress Relay and selects Individual and is prompted to enter the MMSI	From testing.
Radio B	Operator selects Distress Relay—Individual-- from the menu and inputs the MMSI which can only be a coast station ID (double zero beginning)	From Manual.
Radio E	Operator selects individual call and is prompted to enter the MMSI.	From manual.
Radio A	Operator selects Relay—Individual –and enters the MMSI of the coast station	From manual.
Radio D	Operator selects Distress Relay from menu, then selects Individual call and is prompted for the MMSI of the station.	From manual.

Table 1212

Entering ship's MMSI	Source	
Radio C	Only allows the MMSI to be entered once.	From testing.
Radio B	Only allows the MMSI to be entered once.	From testing.
Radio E	Only allows the MMSI to be entered once.	From testing.
Radio A	Only allows the MMSI to be entered once.	From testing.
Radio D	Only allows the MMSI to be entered once.	From testing.

1....Three FCC engineers--Mr. Robert Bradley, Mr. James Higgins and Mr. George Dillon--conducted the tests during the week of September 20-24, 1998.
2....E-mail from Lt. Heather Waddington, USCG, to Joe Hersey, USCG, dated October 3, 1998.
3....Recommendation ITU-R M.493-8, *DIGITAL SELECTIVE-CALLING SYSTEM FOR USE IN THE MARITIME MOBILE SERVICE.*
4....Brand names have been replaced by the first five letters of the Greek alphabet; Alpha, Beta, Chi, Delta and Epsilon.
5....See ¶ 17 for more information on the Distress Acknowledgement testing.
6....*See* Annex 1, § 3.1.3, RECOMMENDATION ITU-R M.541-7, *OPERATIONAL PROCEDURES FOR THE USE OF DIGITAL SELECTIVE-CALLING (DSC) EQUIPMENT IN THE MARITIME MOBILE SERVICE.*